Exercise 30

Suppose that the ship in Exercise 29 is pointing due north and traveling at a speed of 4 knots relative to the water. There is a current flowing due east at 1 knot. The units on the chart are nautical miles; 1 knot = 1 nautical mile per hour.

(a) If there were no current, what vector **u** would represent the velocity of the ship relative to the sea bottom?

(b) If the ship were just drifting with the current, what vector **v** would represent its velocity relative to the sea bottom?

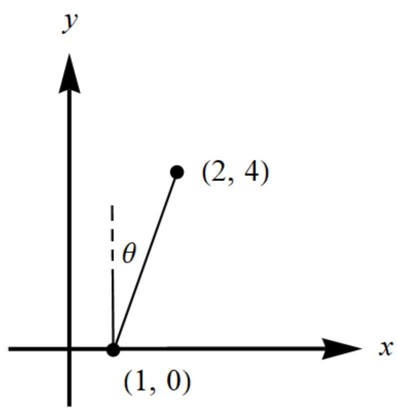
(c) What vector **w** represents the total velocity of the ship?

(d) Where would the ship be after 1 hour?

(e) Should the captain change course?

(f) What if the rock were an iceberg?

Solution



The vector joining the ship to the rock is

$$(2,4)-(1,0)=(1,4) \text{ nautical miles.}$$

The angle is

$$\tan\theta = \frac{1}{4} \quad \to \quad \theta = \tan^{-1}\frac{1}{4} \approx 14.04°.$$

Part (a)

If the ship is moving to the north at 4 knots relative to the water, and the water is still relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{u} = (0,4)+(0,0) = (0,4) \text{ knots.}$$

Part (b)

If the ship is still relative to the water, and the water is moving at 1 knot to the east relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{v} = (0,0) + (1,0) = (1,0) \text{ knots.}$$

Part (c)

If the ship is moving at 4 knots to the north relative to the water, and the water is moving at 1 knot to the east relative to the ground, then the ship's speed relative to the ground is

$$\mathbf{w} = (0,4) + (1,0) = (1,4) \text{ knots.}$$

Part (d)

The ship's location after a time t (in hours) is

$$\begin{aligned} \mathbf{y}(t) &= \mathbf{w}t + \mathbf{y}_0 \text{ nautical miles} \\ &= (1,4)t + (1,0) \\ &= (t,4t) + (1,0) \\ &= (t+1,4t). \end{aligned}$$

The ship's location after one hour is

$$\mathbf{y}(1) = (2,4) \text{ nautical miles,}$$

which is the rock's location.

Part (e)

The captain should change course if he doesn't want the ship to crash.

Part (f)

The captain should change course if he doesn't want the ship to crash.